UMR-IW Navigation Study

Fishery Impact Assessment Studies

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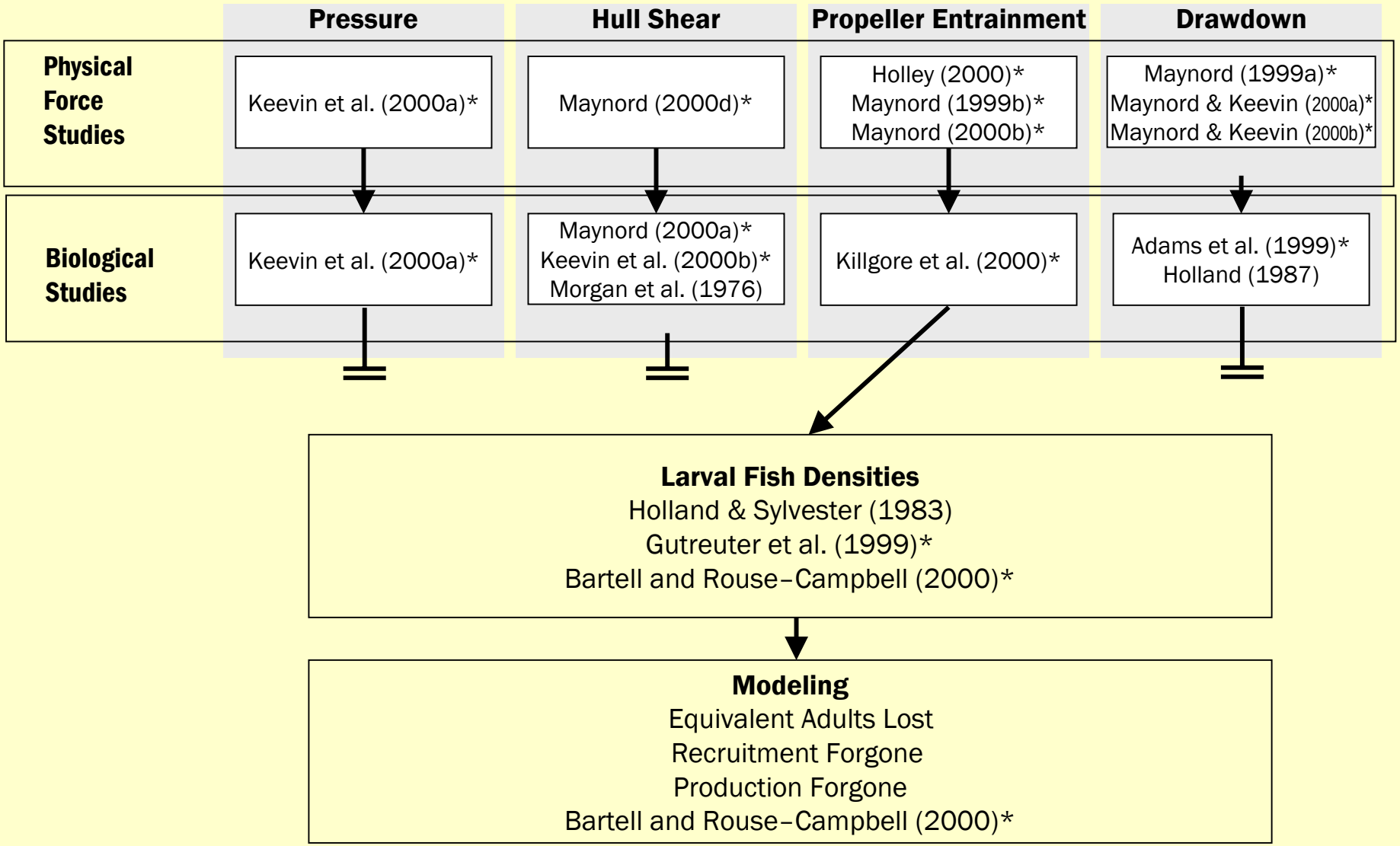
Fishery Impact Assessment Studies

- Larval Fish Studies
- Adult Mortality Studies

Flow Diagram of Larval Fish Studies



*Indicates studies conducted for the Navigation Study

EFFECTS OF PRESSURE CHANGES INDUCED BY COMMERCIAL NAVIGATION TRAFFIC ON MORTALITY OF EARLY LIFE STAGES OF FISH

CYCLE 1 - Pressure was gradually raised to 446.1 kPa over 1 hr, held for 30 min, and returned to atmospheric pressure in 5 sec.

CYCLE 2 - Pressure was raised to 446.1 kPa within 5 sec, held for 10 sec, and returned to atmospheric pressure in 5 sec.

CYCLE 3 - Pressure was raised to 446.1 kPa within 5 sec, held for 30 min, and returned to atmospheric pressure in 5 sec.

Species Tested
Mean and Range of Total Length, mm
(N=50)

Species	Mean	Range	S.D.
Bigmouth buffalo	10.8	7.9-12.6	0.93
Blue catfish	16.2	14.4-17.8	0.73
Bluegill	15.7	10.7-24.2	3.01
Largemouth bass	23.2	16.9-29.0	3.21
Walleye	9.2	7.5-10.1	0.59

Cumulative Mortality of Experimental and Control Fish at 1-, 4-, and 8-hr Post-exposure to Three Pressure Change Regimes (N=100)

Bigmouth Buffalo

	Cumulative Percent Mortality		
	1 hr	4 hr	8 hr
Cycle 1	0	0	1
Control	0	0	0
Cycle 2	0	0	3
Control	0	1	1
Cycle 3	1	1	1
Control	0	0	0

Pressure (kPa) Experienced by Larval fish with Depth, (Meters)

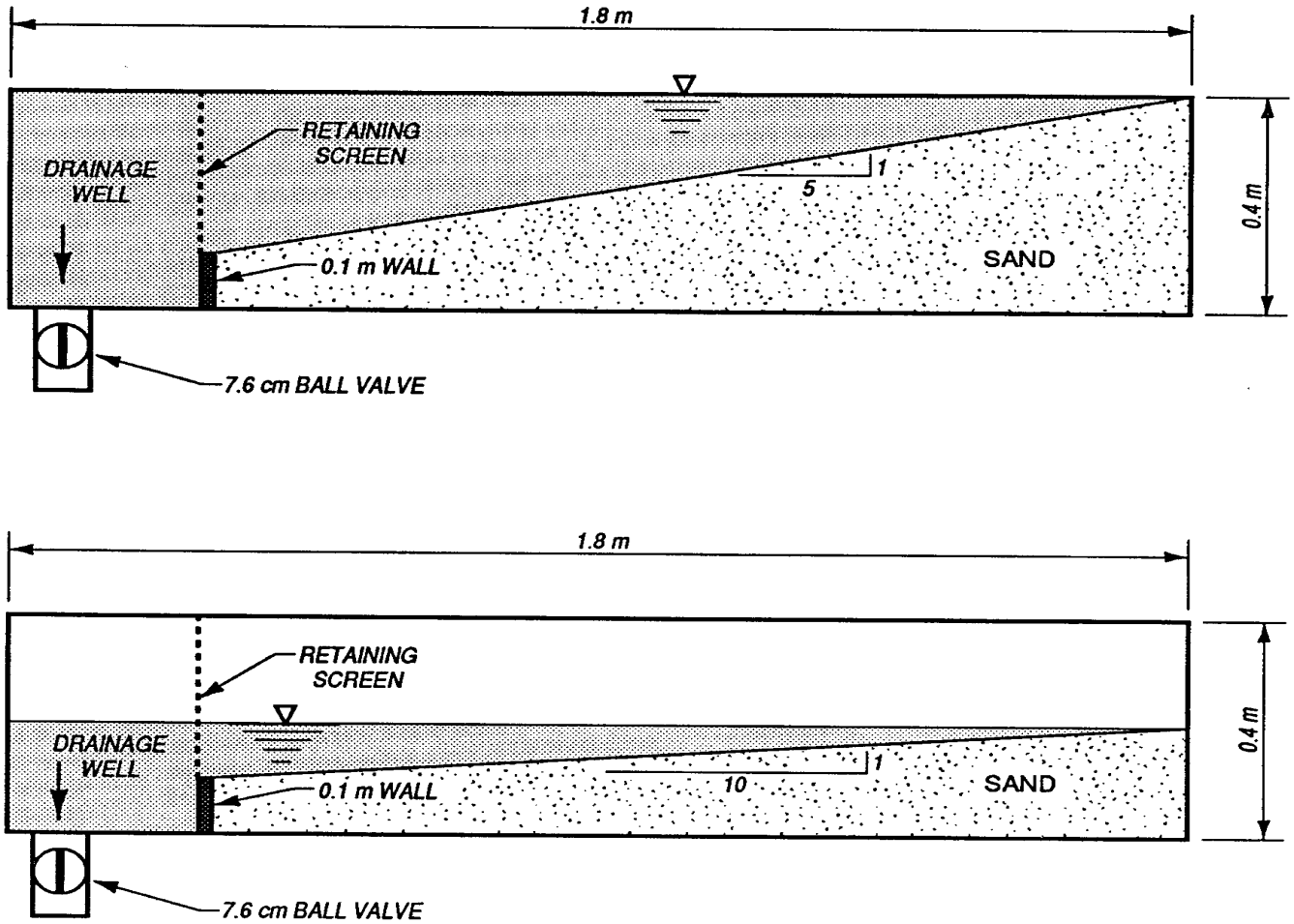
Depth, m	Absolute Pressure, kPa, @STP
0	101.3
2.7	127.8
3.0	130.7
5.0	150.3
10.0	199.3
20.0	297.3
30.0	395.3
35.2	446.1
40.0	493.3

STRANDING POTENTIAL OF YOUNG FISHES SUBJECTED TO SIMULATED VESSEL-INDUCED DRAWDOWN

Holland, L.E. 1987. Effects of brief navigation-related dewatering on fish eggs and larvae. North American Journal of fisheries Management 7:145-147

- Walleye, Northern Pike
- EGGS
  - Dewatering (2 minutes air exposure) did not cause mortality.
- LARVAE
  - Significant mortality at dewatering frequencies of 1 and 3 hours.
  - Significant mortality at 8 tows per day

Adams, S. R., T. M. Keevin, K. J. Killgore, and J. J. Hoover. 1999. Stranding potential of young fishes subjected to simulated vessel-induced drawdown. Transactions of the American Fisheries Society 128:1230-1234.



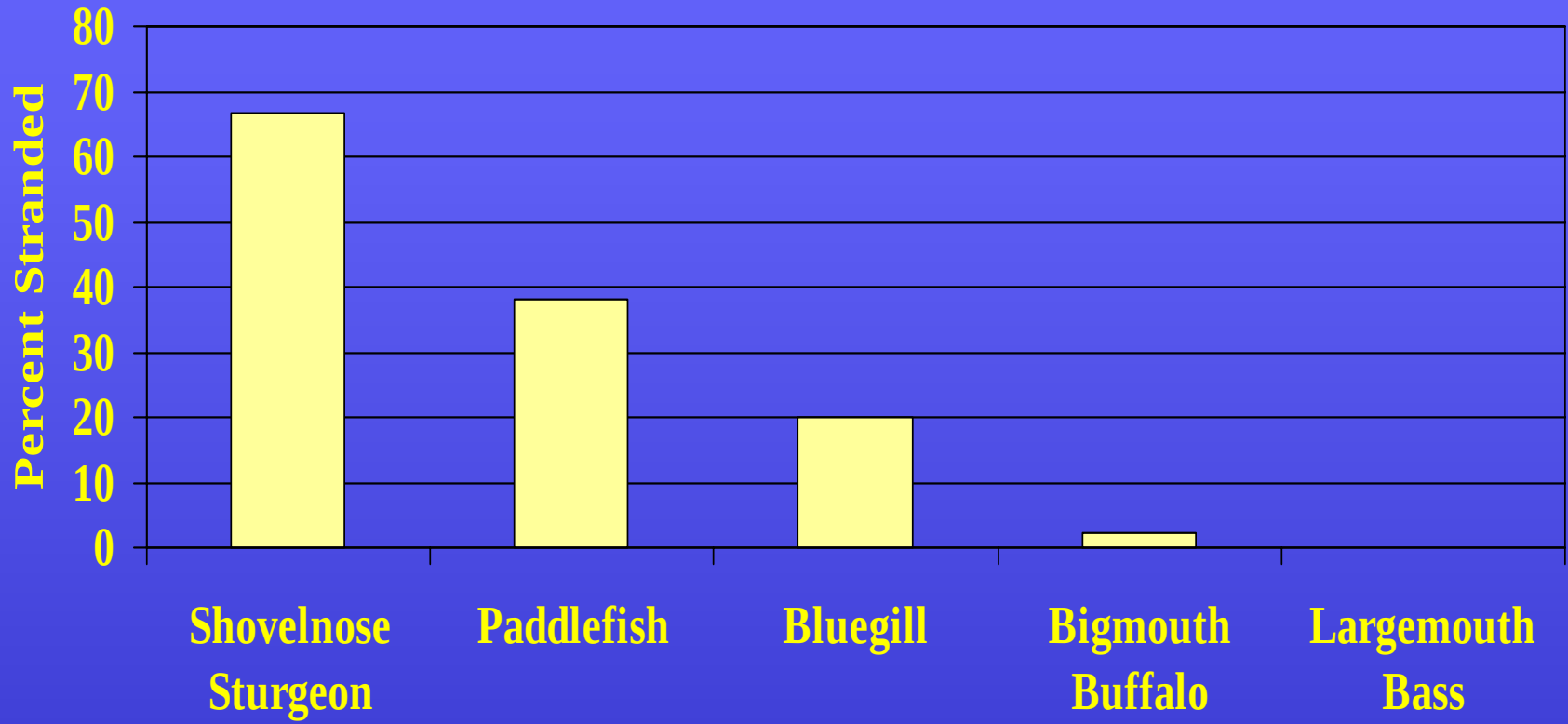
Mean percent stranded of fish species and number of replicates (N) at each drawdown rate when the slope was 1:5.

Species	Drawdown (cm/sec)	N	Percent Stranded Mean	S.D.
Shovelnose sturgeon	0.76	2	75.0	21.21
	0.46	2	60.0	14.14
	0.21	2	65.0	21.21
Paddlefish	0.76	5	40.0	10.00
	0.46	5	32.0	21.68
	0.21	5	42.0	10.95

Mean percent stranded of fish species and number of replicates (N) at each drawdown rate when the slope was 1:5.

Species	Drawdown (cm/sec)	N	Percent Stranded Mean	S.D.
Bigmouth buffalo	0.76	6	3.3	5.16
	0.46	6	3.3	5.16
	0.21	6	0	0
Largemouth bass	0.76	3	0	0
	0.46	4	0	0
	0.21	4	0	0
Bluegill	0.76	3	13.33	11.55
	0.46	3	20.00	20.00
	0.21	3	26.67	23.09

Simulated Stranding of Larval Fish



COMMERCIAL NAVIGATION TRAFFIC INDUCED SHORELINE DEWATERING ON THE UPPER MISSISSIPPI RIVER: IMPLICATIONS FOR LARVAL FISH STRANDING

Hectares of Shoreline Dewatered and Width of Dewatering Zone for the Peak Larval Fish Density, May and June

Shoreline Dewatered (Hectares)	May	June
Pool 4	3.9	4.4
Pool 8	5.5	5.8
Pool 13	4.4	4.5
Pool 26	0.9	1.1

Average Width Dewatering (Meters)		
Pool 4	0.346	0.389
Pool 8	0.491	0.525
Pool 13	0.266	0.274
Pool 26	0.051	0.066

ARE LARVAL FISH IMPACTED BY NAVIGATION TRAFFIC RELATED DRAWDOWN?

Behavioral Studies: Littoral Zone Species are Less Susceptible to Stranding than Main Channel Species. They Possess Behavioral Swimming Adaptations.

Mortality Studies: Significant Mortality of Larval Walleye and Northern Pike Occurred at Dewatering Frequencies of Eight Tows per Day.

Width of Dewatered Shoreline: The Width of Dewatered Shoreline is Less than 0.39 m for 90% of Tow Passages. The Zone is Narrow and Larval Fish May Not Remain Within the Zone for Repeated Aerial Exposures.

Wind Related Natural Dewatering: 20 mph (32.3 km per hour) Produces Drawdown and Associated Dewatering Comparable to Navigation Related Drawdown.

MORTALITY OF FISH EARLY LIFE STAGES RESULTING FROM HULL SHEAR STRESS ASSOCIATED WITH PASSAGE OF COMMERCIAL NAVIGATION TRAFFIC

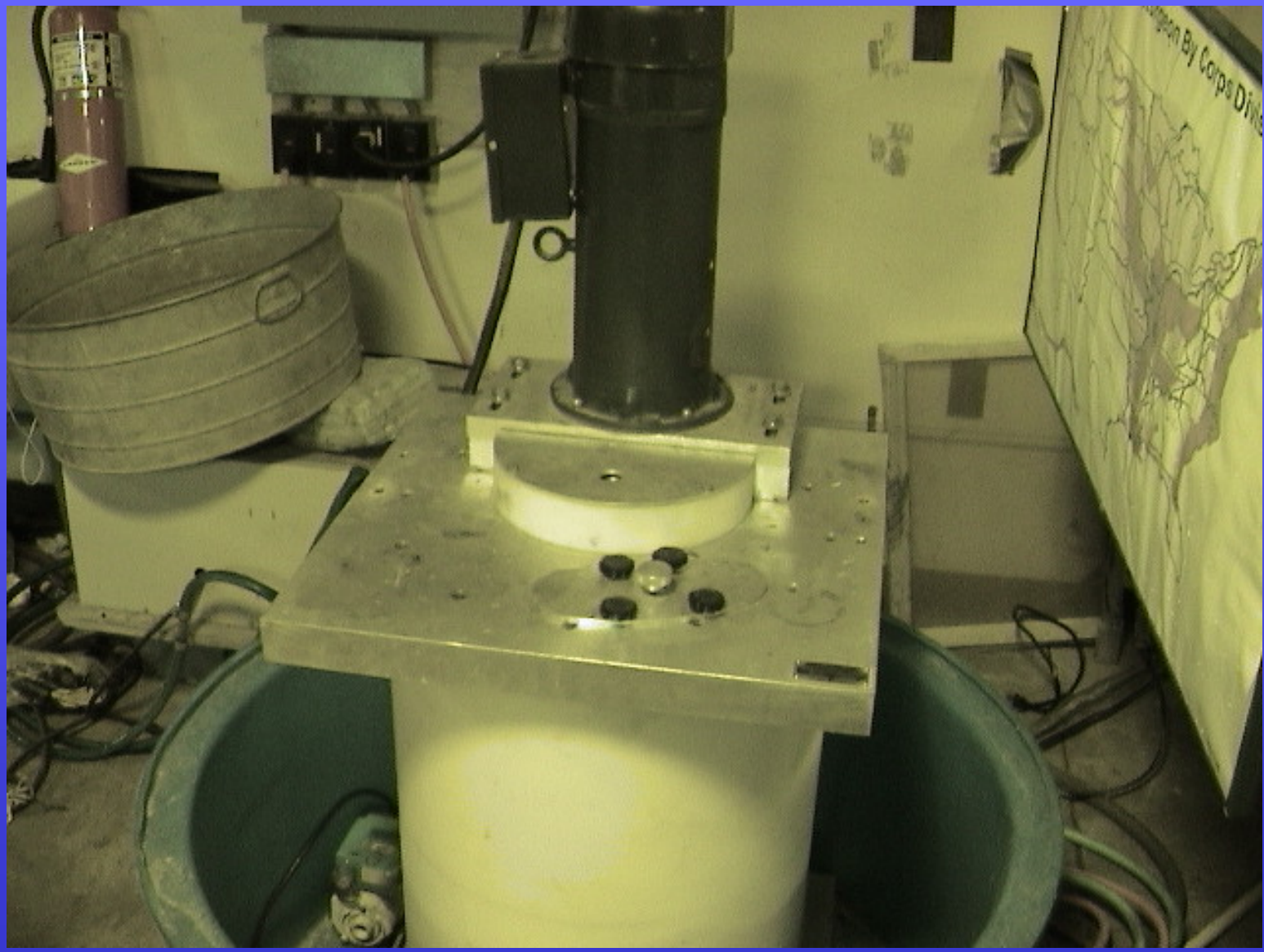
SPECIES STUDIED

Larval

- Shovelnose sturgeon
- Bigmouth buffalo
- Blue Catfish

Juvenile

- Bluegill
- Largemouth bass



Representative Shear Stress Values (Dynes/cm^2) for Two Vessel Speeds and Two Depth/Draft Ratios.

Vessel Speed (m/sec)	Depth/Draft Ratio	Exposure (sec)	Representative Shear Stress (dynes/cm^2) for percent exceedance		
			50	10	5
2.9	1.22	102	87	129	142
4.0	1.22	74	135	225	250
2.9	2.0	102	53	107	115
4.0	2.0	74	57	187	204

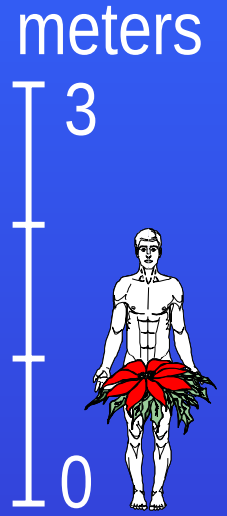
RESULTS

The hull of a high-speed tow (4.0 m/sec) with a 1.22-depth/draft ratio will produce a shear stress of 250 dynes/cm^2 in 5% of the zone beneath the tow. This was the only area in the water column where hull shear stress values approached levels causing significant ($P<0.05$) mortality of bigmouth buffalo larvae.

UMRS-IW Navigation Study

Adult Fish Mortality Studies

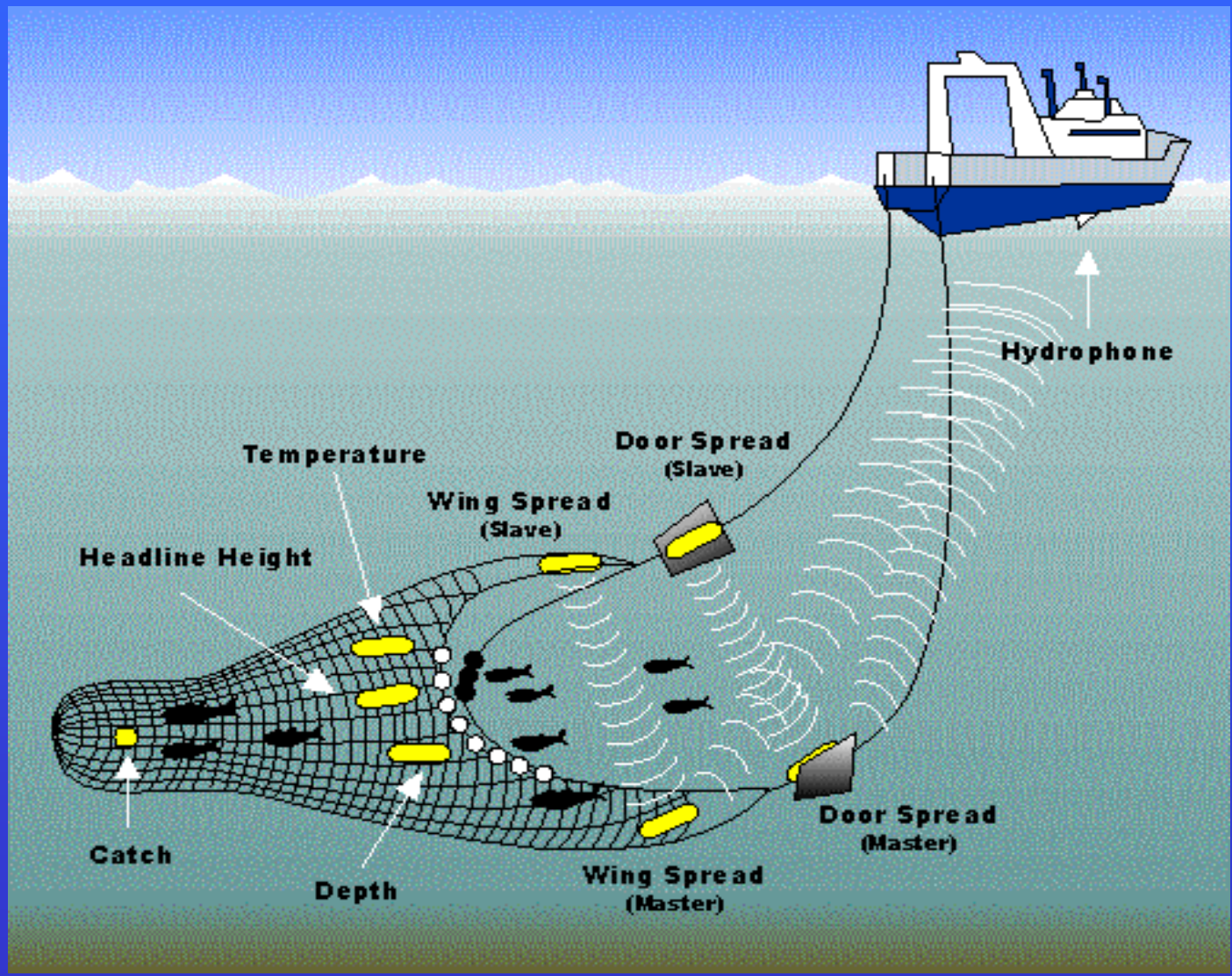
Potential for Entrainment



Courtesy Harrington Marine

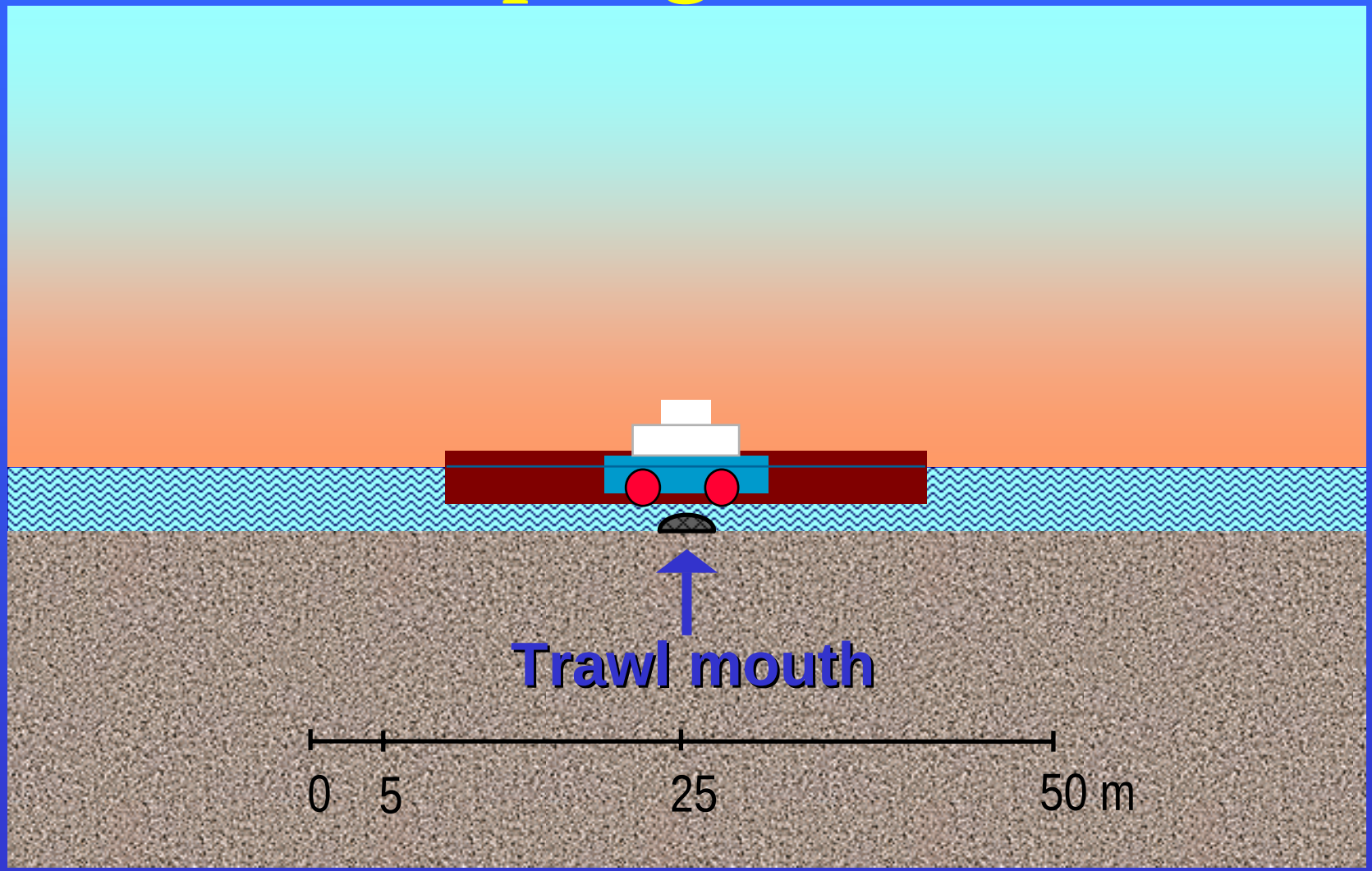

No25

Adult Entrainment Study - USGS



Courtesy Northwest Technical Ltd

The Sampling Problem…



Sampling Performance 1996-97 & 2000-01

Sample type	Sample size (# trawls)	Observed Kills
Entrainment	**155**	**4**†
Ambient	**110**	**3**‡

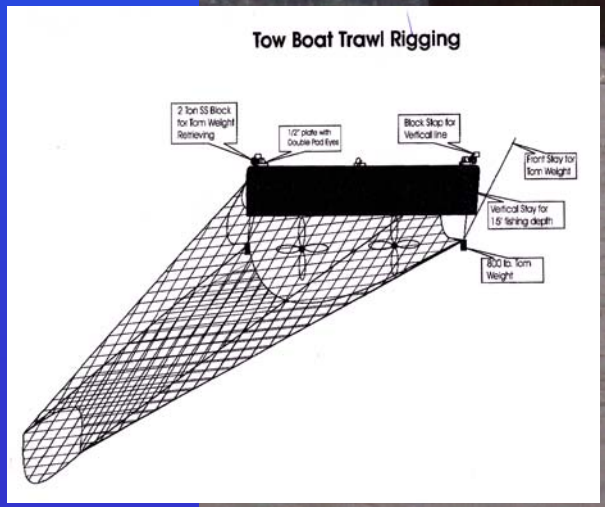
† 3 gizzard shad, 1 skipjack herring

‡ 1 gizzard shad, smallmouth buffalo & shovelnose sturgeon

Entrainment Mortality Rate Estimates

Species	Mortality rate (kills/km)	80% Confidence
Gizzard shad	2.52	1.00-6.09
Skipjack herring	0.13	0.00-0.41
Shovelnose sturgeon	0.53	0.00-1.33
Smallmouth buffalo	0.53	0.00-1.33

Adult Entrainment Study - ERDC

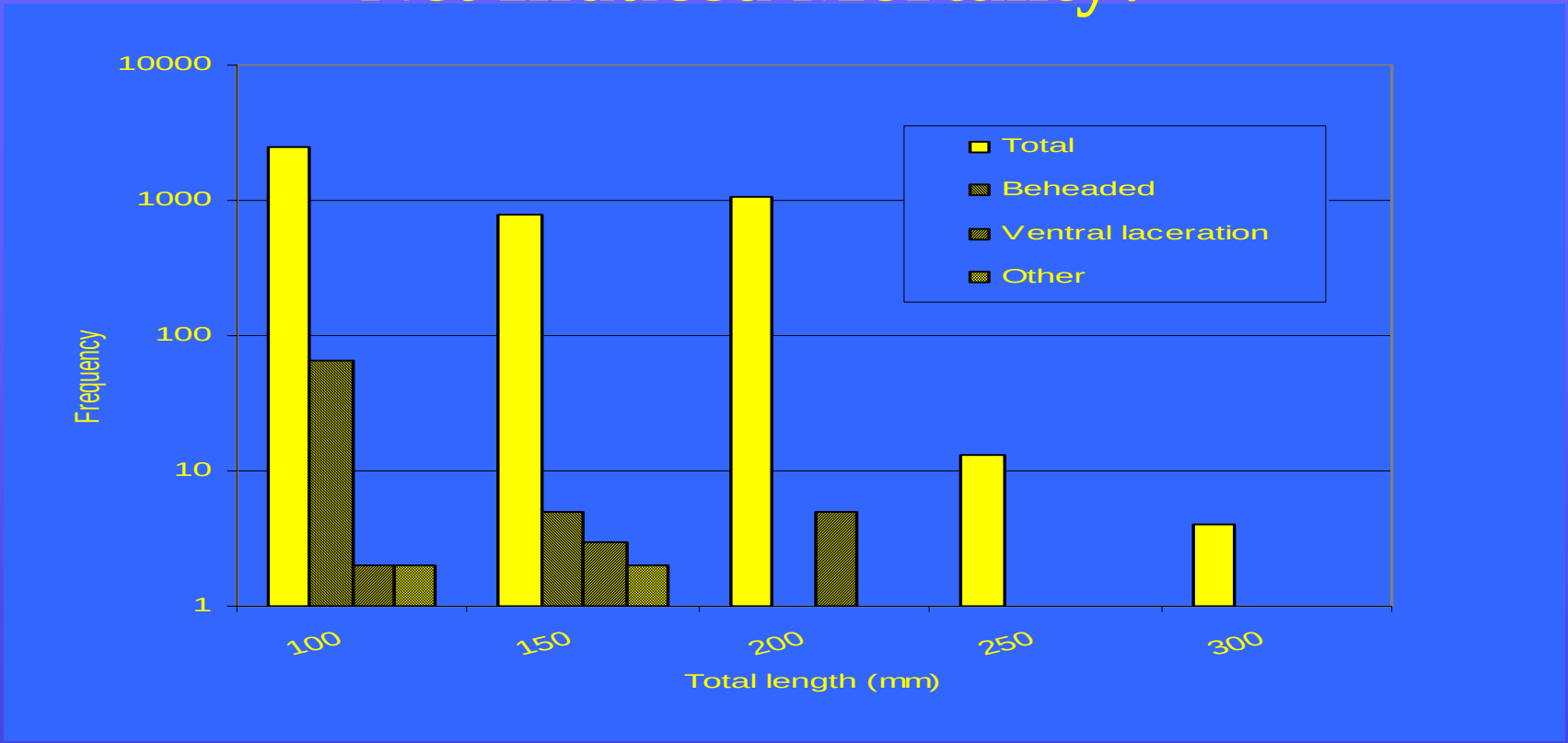


Retrieving Fish From Codend

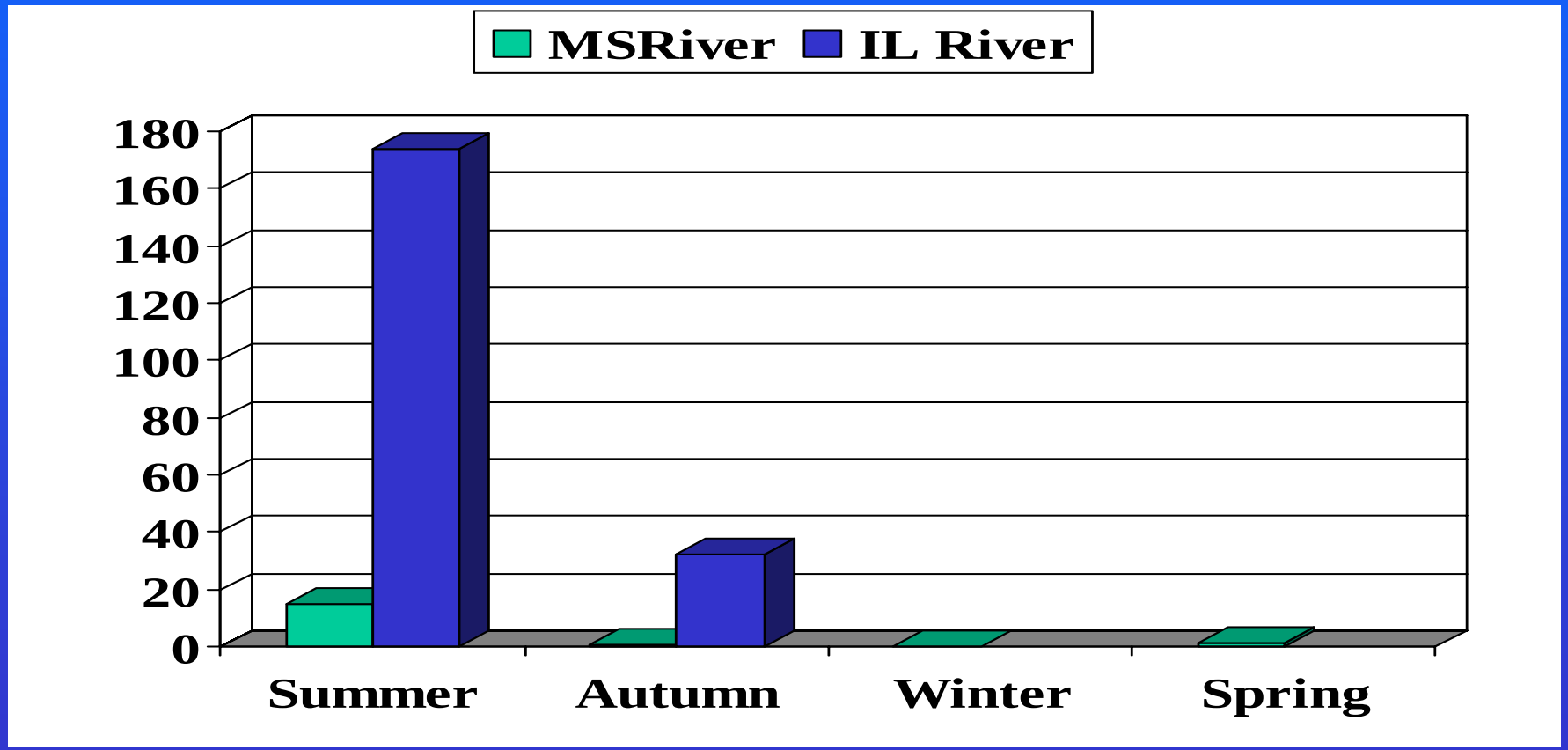
Study Results

- 139 trawl samples completed
- 4567 live fish collected
- 15 species
- 96% Gizzard Shad
- 2 fish with apparent blade injuries
- 107 exhibited injuries
- 0.5 fish/km Mississippi River
- 1.0 fish/km Illinois River

Net Induced Mortality?



Fish per Trawl



UMRS-IW Navigation Study

Lock Mortality Study


CE-95-596


No.25

Lock & Dam 25 June 2002 Summer Sample

open river conditions

	GS	FD	BC	CC	Other	TOTAL
Nan	----	----	----	----	----	0
Hornet	----	----	----	----	----	0
DeSalle	----	----	----	----	----	0
Jamie Leigh	1	----	----	----	----	1
Ruth D. Jones	----	----	----	----	----	0
Washington	----	----	----	----	----	0
Greg Mintor	----	----	----	----	----	0
Tom Behringer	----	----	----	----	----	0
Andrew Cannava	----	----	----	----	----	0
Justin Paul Eckstein	----	----	----	----	----	0
Philip M. Pheipher	----	----	----	----	----	0

June

- 11 lockages sampled
- 1 dead gizzard shad
- Open river conditions

Lock & Dam 25 August 2002 Summer Sample
pooled river conditions

	GS	FD	BC	CC	Other	TOTAL
Penny Eckstein	----	----	----	----	----	0
Prosperity	----	----	1	----	----	1
Martha R. Ingram	9	2	2	----	----	13
Cooperative Mariner	----	2	----	----	1*	3
Jack D. Wofford	3	1	----	----	----	4
Bill Berry	51	2	2	2	----	57
James F. Neal	5	----	----	----	----	5
Cooperative Ambassador	2	1	----	----	----	3
Prairie Dawn	4	----	----	----	----	4
Mary Kay Eckstein	----	1	----	----	----	1

* Bigmouth buffalo

August

- 10 lockages sampled
- Pooled river conditions
- 91 fish killed
  - 74 gizzard shad
  - 9 freshwater drum
  - 5 blue catfish
  - 2 channel catfish
  - 1 bigmouth buffalo
- 2 towboats responsible for 75% of mortality
  - Bill Barry, 57 dead fish (63% mortality)
  - Martha Ingram, 13 dead fish (14% mortality)

Lock & Dam 25 October 2002 Fall Sample

pooled river conditions

	GS	FD	BC	CC	Other	TOTAL
Ruth D. Jones	----	----	----	----	----	0
L. J. Sullivan	----	----	----	----	----	0
Tom Frazier	----	----	----	----	----	0
Jacob Michael Eckstein	7	----	----	----	----	7
Thomas Eckstein	----	----	----	----	----	0
Gene Herde	----	----	----	----	----	0
Daniel Webster	----	----	----	----	----	0
Hornet	----	5	----	----	----	5
R.W. Naye	3	1	----	----	2*	6
Bruce R. Birmingham	----	----	----	----	----	0
Andrew Cannava	----	----	----	----	----	0
Theresa L. Wood	----	----	----	----	----	0
Greg Minton	2	2	----	----	----	4
Dell Butcher	----	----	----	----	----	0
K.L.S. Erickson	1	----	----	----	----	1
Hornet	----	5	----	----	----	5
Ardyce Randall	----	----	----	----	----	0
John M. Rivers	1	----	----	----	----	1
Starfire	----	----	----	----	----	0
Theresa L. Wood	5	2	----	2	----	9
Cooperative Venture	----	----	----	----	----	0

* sauger

October

- 21 lockages sampled
- Pooled river conditions
- 36 fish killed
  - 20 gizzard shad
  - 15 freshwater drum
  - 2 sauger
- No mortality 13 lockages (62% of lockages)

Lock & Dam 25 December 2002 Winter Sample

pooled river conditions

	GS	FD	BC	CC	Other	TOTAL
Jack D. Wofford	14	----	----	----	----	14
W.A. Kernan	5	----	----	----	----	5
Arlie	----	----	----	----	----	0
Phylis	2	----	----	----	----	2
Senator Sam	19	2	----	----	----	21
Kathy Ellen	5	----	----	----	----	5
Floyd H. Blaske	28	----	----	----	----	28
Tom Behringer	----	----	----	----	----	0
Sierra Dawn	5	----	----	----	----	5
Richard Baker	12	----	----	----	----	12
Milton V. Roth	1	----	----	----	----	1
Kevin Michael	2	----	----	----	----	2
Cindy L. Erickson	----	----	----	----	----	0
Stephen Colby	----	----	----	----	----	0
L.W. Hershey	----	----	----	----	----	0
Beverly Ann	60	----	----	----	----	60
Ruth B. Jones	9	----	----	----	----	9
Richard Baker	----	----	----	----	----	0

December

- 18 lockages sampled
- Pooled river conditions
- 164 fish killed
  - 162 gizzard shad
  - 2 freshwater drum
- No mortality 6 lockages (33% of lockages)
- 3 towboats responsible for 65% of mortality

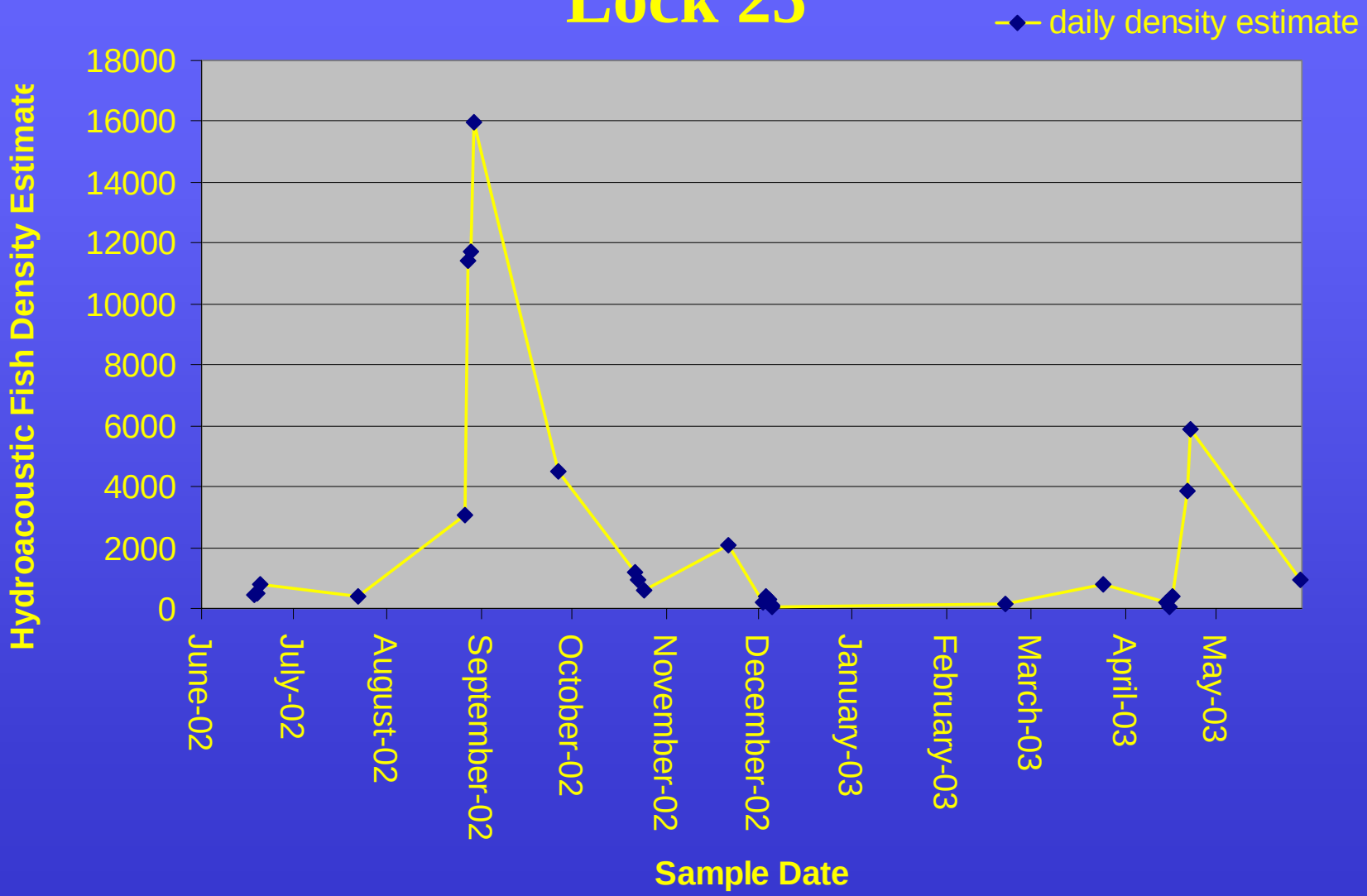
Lock & Dam 25 April 2003 Spring Sample
pooled river conditions

	GS	FD	Other spp.	TOTAL
George King	2	1	2 bigmouth buffalo	5
Jeffery G.	----	2	2 smallmouth buffalo	4
Coop. Ambassador	----	2	----	2
Ruth D. Jones	1	2	----	3
Jeffery G.	----	2	----	2
Mary Kay Eckstein	2	----	----	2
Roberta Tabor	----	----	----	0
James Ermer	2	----	2 smallmouth buffalo	4
Afton	1	0	1 white bass, 2 walleye	4
Arnold Sobel	1	----	----	1
Show Me State	----	3	1 white bass	4
Cooperative Venture	----	----	2 paddlefish	2
Stephen L. Colby	2	2	----	4
Carol P.	----	2	4 common carp	6
Carol Dawn	----	----	----	0
Prairie Dawn	2	----	----	2
Roy E. Claverie	5	----	2 sm. buffalo, 2 w. bass	9
Carol P.	----	3	2 sauger, 2 sn. gar	7
Robert Green	2	----	----	2
Marie Hendrick	3	2	1 channel catfish	6

April

- 20 lockages sampled
- Pooled river conditions
- 69 fish killed
  - 23 gizzard shad
  - 21 freshwater drum
  - 6 smallmouth buffalo
  - 4 white bass
  - 2 paddlefish
  - 2 shortnose gar
  - 4 common carp
  - 2 bigmouth buffalo
  - 2 sauger, 2 walleye
  - 1 channel catfish
- Mortality 18 lockages (90% of lockages)

Seasonal Hydroacoustic Fish Densities
Lock 25



Tow Characteristics

Tow	Owner	Date in 2003	Time	Direction	Loads/empties
Greg Minton	Marquette	4/14	1941	Up	0/16
Mary K Eckstein	Marquette	4/15	0817	Up	0/16
Roberta Tabor	ARTCO	4/15	1115	Down	15/0
James Ermer	ACBL	4/15	1446	Down	15/0
Cooperative Vanguard	ARTCO	4/15	1800	Down	15/0
Afton	ACBL	4/16	0745	Down	14/1
Arnold Sobel	ACBL	4/16	1030	Down	15/0
Show Me State	Marquette	4/16	1400	Down	15/0

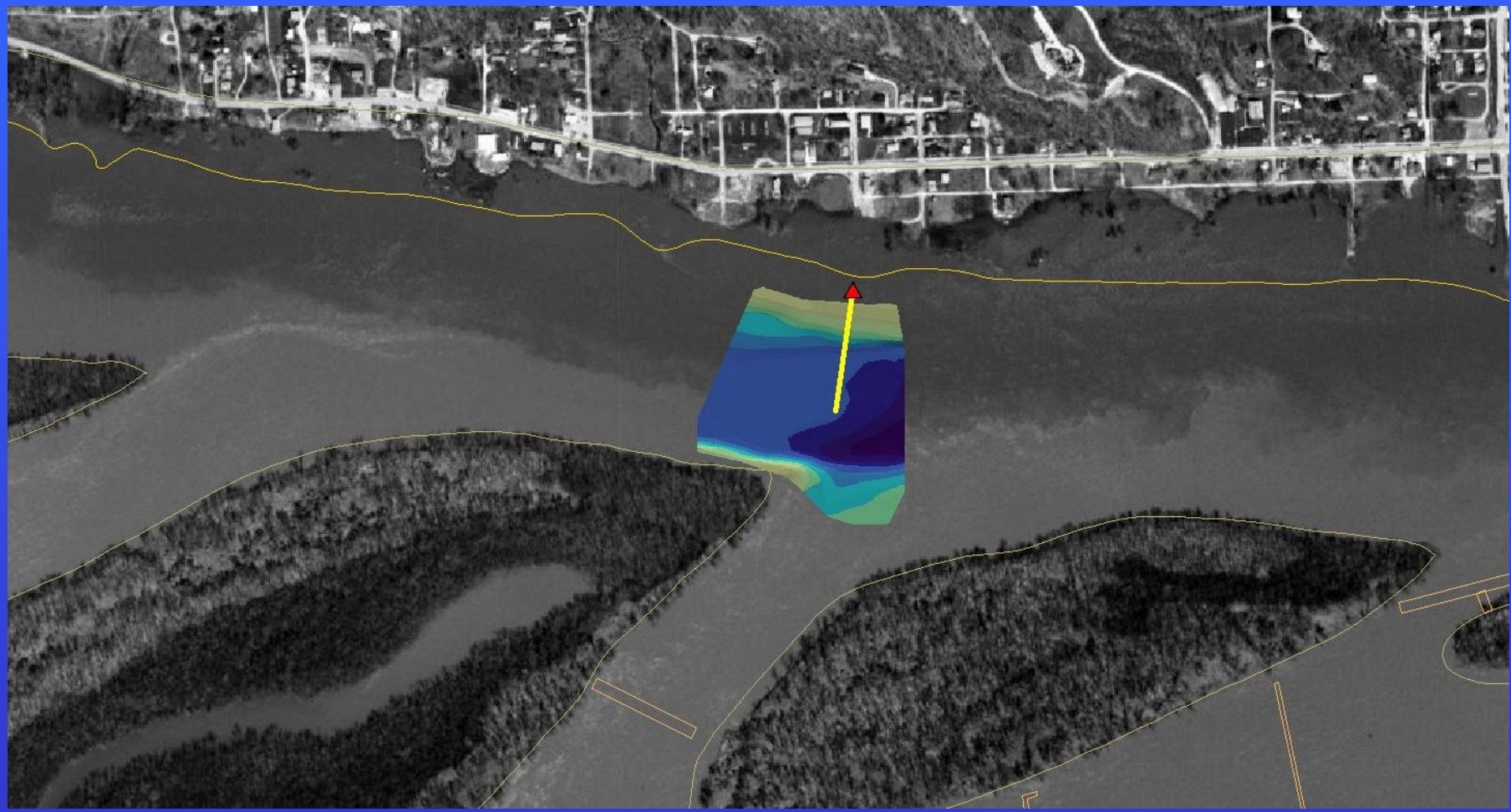
Percentage of Lock 25 Water Volume Going Through the Props

- Average upbound unloaded tow passed 49% of water volume through the wheels
- Average downbound loaded tow passed 228% of water volume through the wheels

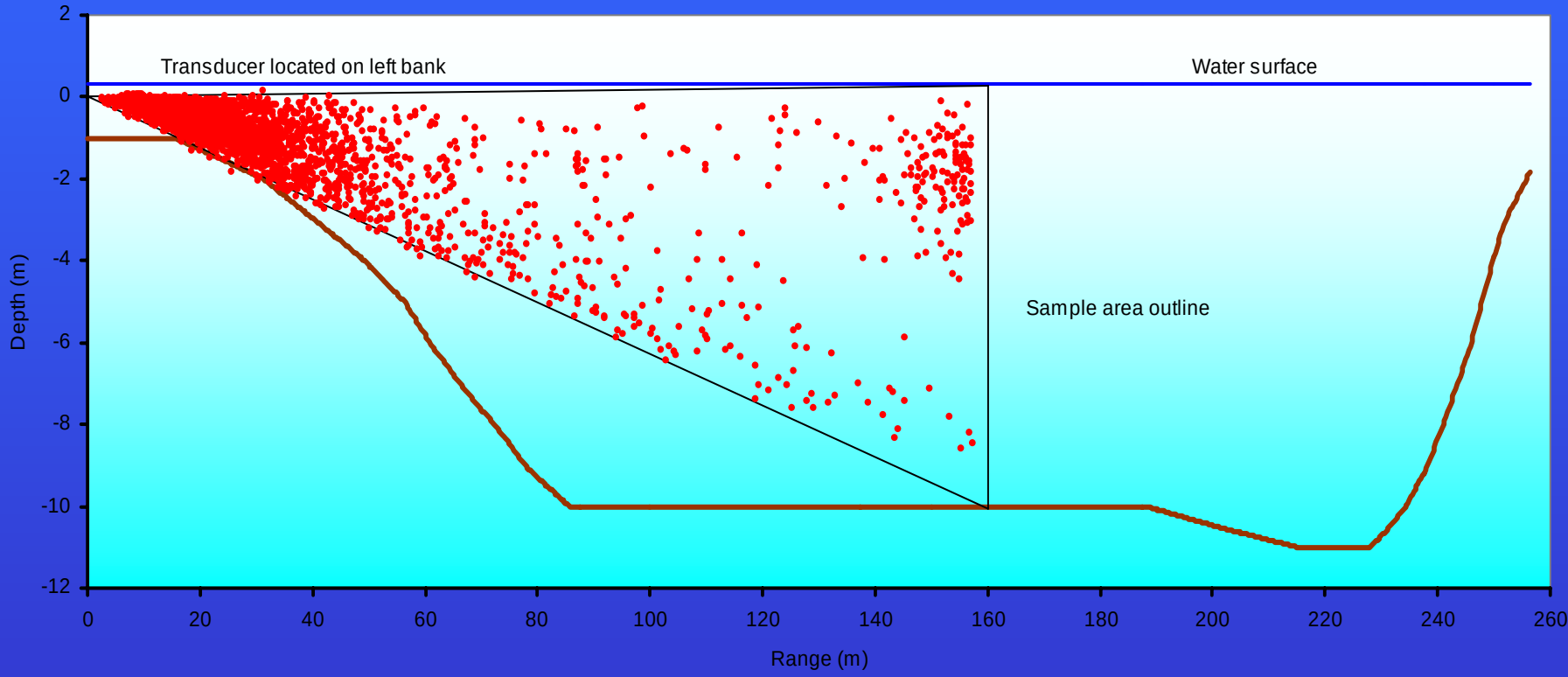
Believe it or not!

UMRS-IW Navigation Study

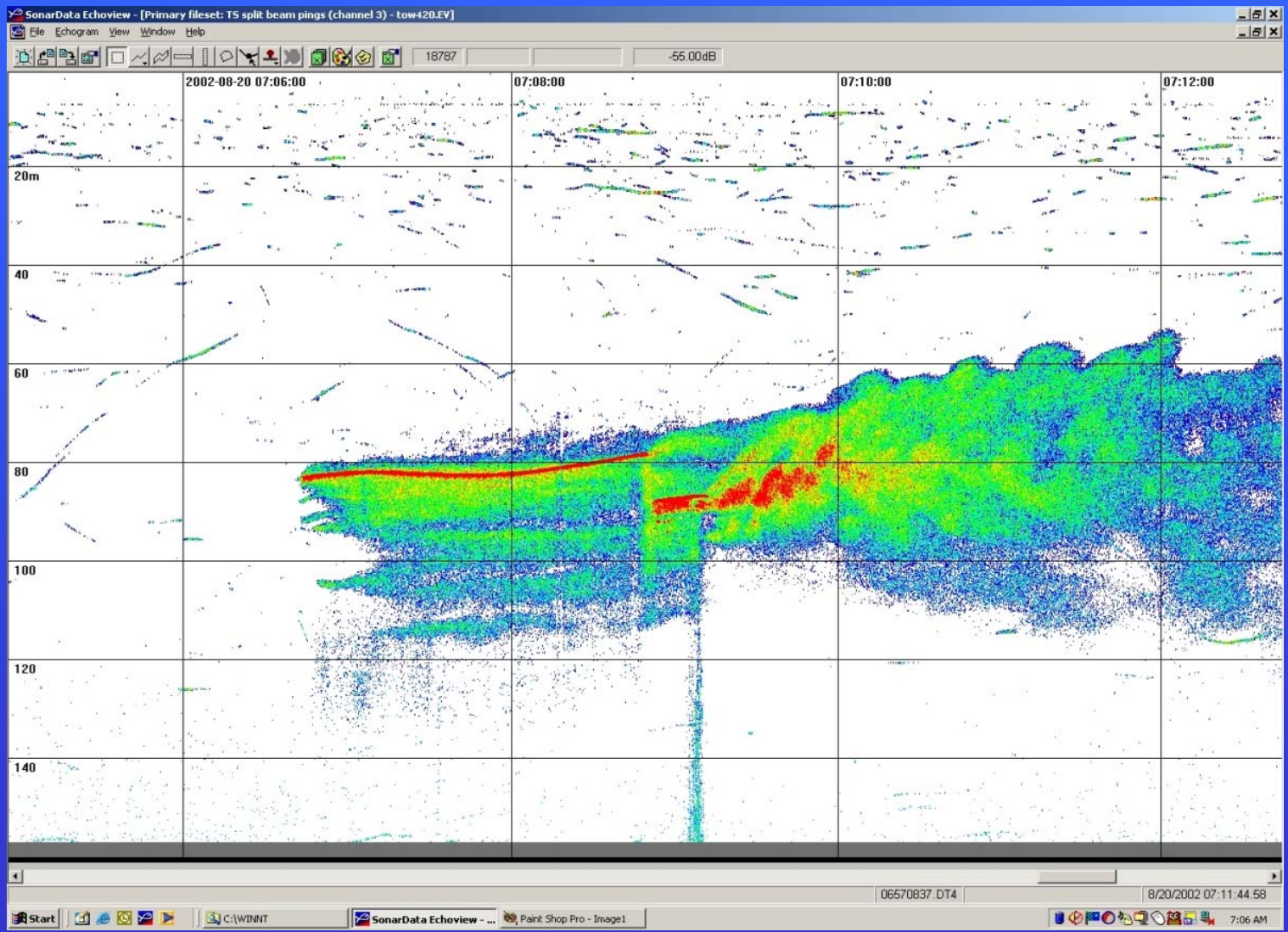
Barge Avoidance Study



Location of tracked fish during 4 tows



MV Dell Butcher 15 loaded barges heading upstream 8/20/02 0700



Tracked fish near the Dell Butcher 08/20/2002 at 0706 hrs

SUMMER SAMPLE

- 37 tows sampled
- Tow events: 8,958 fish tracked
- No-tow period: 6,460 fish tracked
- Fish in front of tow: Moved deeper in the water column 21% more
- Fish on side of tow: Moved horizontally away 20% more

FALL SAMPLE

- 48 tows sampled
- Tow events: 38,509 fish tracked
- No-tow period: 9,784 fish tracked
- Day: Fish moved away from tows in either the Z or Y axis.
- Night: Fish moved away from tows in the Z direction.
- Fish on side of tow: Moved horizontally away 88% more

WINTER SAMPLE

- 37 tows sampled
- Tow events: 3,732 fish tacked,
- No-tow period: 2,448 fish tracked
- Avoidance within 10 m of the tows was high during all seasons except winter.
- Low water temperatures contributed to less avoidance behavior

SPRING SAMPLE

- 29 tows sampled
- Tow events: 1,373 fish tacked
- No-tow period: 624 fish tracked
- Small sample size for main channel fish
  - 7 fish during tow periods
  - 14 fish during no-tow periods
- Fish alongside the tows moved away in the Y axis, or vertically, from the tows but not horizontally

Entrainment Mortality Rate Estimates Upper Mississippi River

Species	Mortality rate (kills/km) all fish	Mortality rate (kills/km) prop only
All Species	.5	.01
Gizzard shad	.4	0
Skipjack herring	.1	.01
Freshwater drum	< .1	0

Lock 25 Hydroacoustic Fish Densities

Date	Average	95% CI Lower	95% CI Upper
6/18/02	437	336	538
6/19/02	517	416	618
6/20/02	802	592	1,011
7/22/02	419	-78	916
8/26/02	3,081	2,259	3,904
8/27/02	11,419	6,018	16,821
8/28/02	11,716	-155	23,587
8/29/02	15,957	10,524	21,391
9/26/02	4,477	3,355	5,599
10/21/02	1,195	686	1,703
10/22/03	943	869	1,917
10/24/02	590	297	883
11/21/02	2,054	1,153	2,956
12/02/02	174	60	288
12/03/02	378	26	730
12/04/02	308	166	450
12/05/02	77	13	141

Lock 25 Hydroacoustic Fish Densities

Date	Average	95% CI Lower	95% CI Upper
1/00/03	River Frozen, No Access		
2/20/03	163	39	287
3/24/03	809	302	1,316
4/14/03	206	-72	484
4/15/03	59	-56	174
4/16/03	383	226	540
4/21/03	3,881	788	6,974
4/22/03	5,909	2,010	9,809
5/28/03	941	459	1,423

The pictures the Corps didn’t want you to see


No.25